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25. (Amended) A semiconductor device, comprising:

a wiring layer connected to an electrode pad formed on a semiconductor substrate;

an insulating layer formed on the wiring layer and having an opening therein which exposes an upper surface portion of the wiring layer;

a metal layer completely covering the upper surface portion of the wiring layer exposed by the opening, but not side surfaces of the opening; and

a protruding electrode electrically connected to the wiring layer via the metal layer, the protruding electrode being made of Sn or a metal having Sn as its main component,

wherein the wiring layer comprises a first, second and third metal layers, the third metal layer having low reactivity with the material of the insulating layer.

REMARKS

Reconsideration and allowance of the subject patent application are respectfully requested.

Claims 1, 17 and 25 were rejected under 35 U.S.C. Section 112, first paragraph, as allegedly containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. Applicants respectfully submit that one of ordinary skill in the art would understand the step shown in Figure 2(f) of the subject application to involve providing a metal layer only on a bottom surface of the opening section, notwithstanding that there may be some contact of this layer with the side surfaces of the opening section. Thus, Applicants believe that the subject matter of the rejected claims is fully enabled by the originally-filed specification

and drawings. Nonetheless, in order to advance prosecution, Applicants have rewritten claim 1 to specify that the metal layer completely covers the bottom surface, but not side surfaces, of the opening section. This description is fully supported by the originally-filed specification and drawings. Similar amendments have been made to claims 17 and 25. Because these amendments are made by way of clarification and/or will place the application in better form for appeal, entry of these amendments and withdrawal of the Section 112, first paragraph, rejection are believed to be appropriate and are respectfully requested.

Claims 1 and 17 were rejected under 35 U.S.C. Section 102(b) as allegedly being anticipated by Chikawa *et al.* (U.S. Patent No. 5,310,699). Chikawa *et al.* discloses a method of manufacturing a semiconductor device with a bump-electrode of gold crystal. Figure 2F of Chikawa *et al.* shows an electrode layer 3 which is described as being electrically connected to "circuit elements." See col. 4, ll. 1-3. A passivation layer 4 is formed on the electrode layer 3 and an opening in the passivation layer exposes a portion of electrode layer 3. A multilayer film 6 is provided on electrode layer 3. As shown in Figure 2F, the film 6 does not completely cover the exposed surface of electrode 3. A bump electrode 7 is formed on the film 6. Because the multilayer film 6 does not completely cover the electrode layer 3, Chikawa *et al.* cannot anticipate claim 1 which calls for a metal film to completely cover a bottom surface of the opening section on the main conductor layer. Claim 17 calls for a metal layer to completely cover the upper surface portion of the wiring layer exposed by the opening and likewise this claim cannot be anticipated by Chikawa *et al.*

The subject specification describes preventing deterioration of reliability due to gap formation between the metal layer and the insulating layer in the vicinity of a protrudent electrode made of, for example, Sn or a metal having Sn as its main component. Such gap

formation can occur if the metal layer is formed to cover the whole main conductor layer. For example, solder using Sn has a melting point much lower than solder using Au. Because of this, if a metal having a good wetting property were formed on the surface of the main conductor layer other than the opening section of the insulating film, metal other than the metal in the opening section could diffuse into the protrudent electrode. By providing the metal layer so as to cover the exposed upper surface portion of the wiring layer, but not, for example, side surfaces of the opening, no gap is formed between the insulating layer and the protrudent electrode, even if the metal layer diffuses into the protrudent electrode. Thus, it is possible to prevent the deterioration in reliability due to water condensation in the gap.

In addition, claims 1 and 17 now call for the protrudent (or protruding) electrode to be made of Sn or a metal having Sn as its main component. This feature was previously specified in claim 2, for example. In Chikawa *et al.*, the bump electrode 7 identified in the office action as corresponding to the claimed protrudent (protruding) electrode is made of Au (gold). For this additional and independent reason, claims 1 and 17 cannot be anticipated by Chikawa *et al.*

Claims 1-6, 17 and 20-24 were rejected under 35 U.S.C. Section 103(a) as allegedly being "obvious" over Akram (U.S. Patent No. 5,736,446) in view of Chikawa *et al.* Akram shows a metal layer completely covering both the bottom and side surfaces of the opening, while Chikawa *et al.* shows a metal that does not completely cover the bottom surface of the opening.

Consequently, even assuming for the sake of argument that the proposed combination of Akram and Chikawa *et al.* were proper, the combination would nonetheless be deficient at least with regard to "a metal layer completely covering a bottom surface, but not side surfaces, of the opening section on the main conductor layer" as described in claim 1 and "a metal layer completely covering the upper surface portion of the wiring layer exposed by the opening, but not

side surfaces of the opening" as called for in claim 17. Accordingly, the subject matter of claims 1 and 17 and those claims depending therefrom would not have been rendered obvious by the proposed combination of Chikawa *et al.* and Akram.

Claims 7-9, 18, 19, and 25-28 were rejected under 35 U.S.C. Section 103(a) as allegedly being "obvious" over the proposed Akram-Chikawa *et al.* combination, in further view of Okada *et al.* (U.S. Patent No. 6,111,317). Okada *et al.* is applied as allegedly showing a three-layered metal film. However, Okada *et al.* does not remedy the above-noted deficiencies of the proposed Akram and Chikawa *et al.* combination with respect to the metal layer of claims 1 and 17. Claim 25, like claim 17, calls for a metal layer completely covering the upper surface portion of the wiring layer exposed by the opening, but not side surfaces of the opening. Consequently, the proposed combination of Akram and Chikawa *et al.* is also deficient with respect to claim 25 and again Okada *et al.* fails to remedy this deficiency. Accordingly, the combination of Akram, Chikawa *et al.* and Okada *et al.*, even if proper, would not have resulted in the subject matter of claims 7-9, 18, 19 and 25-28.

Claim 10 was rejected under 35 U.S.C. Section 103(a) as allegedly being obvious over the proposed Akram-Chikawa *et al.* combination, in further view of Stamper *et al.* (U.S. Patent No. 6,362,531). Stamper *et al.* however does not remedy the above-identified deficiencies of the proposed Akram-Chikawa *et al.* combination with respect to claim 1 from which claim 10 depends. As such, even assuming (without admitting) the characterizations of Stamper *et al.* in the office action are correct and that the combination of Chikawa *et al.*, Akram and Stamper *et al.* would have been proper, the subject matter of claim 10 would not have resulted.

Applicants submit that the pending claims are in condition for allowance, and action to that end is earnestly solicited.

ISHIO et al. .
Serial No. 09/883,366

If any issues remain to be resolved, the Examiner is urged to contact the attorney for
Applicants at the telephone number listed below.

Respectfully submitted,
NIXON & VANDERHYE P.C.

A handwritten signature in cursive script, appearing to read "Michael J. Shea", written over a horizontal line.

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Version marked to show changes made

IN THE CLAIMS

Claims 1, 2, 17 and 25 have been amended as follows:

1. (Twice Amended) A semiconductor device, comprising:
a main conductor layer having an end that is electrically connected to an electrode pad;
an insulating layer having an opening section on said main conductor layer; and
a protrudent electrode electrically connected to said main conductor layer via said
opening section, said protrudent electrode being made of Sn or a metal having Sn as its main
component,

said semiconductor device further comprising:
a metal layer completely covering [provided only on] a bottom surface, but not side
surfaces, of the opening section on the main conductor layer so that said metal layer is provided
between said main conductor layer and said protrudent electrode.

2. (Amended) The semiconductor device as set forth in Claim 1, wherein:
[said protrudent electrode is made of Sn or a metal having Sn as its main component;
and]

said metal layer is made of Au or a metal having Au as its main component.

17. (Amended) A semiconductor device, comprising:

a conductive wiring layer connected to an electrode pad formed on a semiconductor substrate;

an insulating layer formed on the wiring layer and having an opening therein which exposes an upper surface portion of the wiring layer;

a metal layer completely covering [provided in the opening only on] the [exposed] upper surface portion of the wiring layer exposed by the opening, but not side surfaces of the opening;
and

a protruding electrode electrically connected to the wiring layer via the metal layer, the protruding electrode being made of Sn or a metal having Sn as its main component.

25. (Amended) A semiconductor device, comprising:

a wiring layer connected to an electrode pad formed on a semiconductor substrate;

an insulating layer formed on the wiring layer and having an opening therein which exposes an upper surface portion of the wiring layer;

a metal layer completely covering [provided in the opening only on] the [exposed] upper surface portion of the wiring layer exposed by the opening, but not side surfaces of the opening;
and

a protruding electrode electrically connected to the wiring layer via the metal layer, the protruding electrode being made of Sn or a metal having Sn as its main component,

wherein the wiring layer comprises a first, second and third metal layers, the third metal layer having low reactivity with the material of the insulating layer.